CLAIMS

What is claimed is:

1. An apparatus for harvesting energy from a transducer comprising:

an input storage element, connected to receive an energy signal originated by the transducer and to store electrical energy received therefrom;

a controlled conversion element, connected to the input storage element and to provide a converted signal therefrom, and to constrain an input storage element voltage value to vary only within a controlled operating voltage range that varies from a low operating voltage value to a high operating voltage value, the high operating voltage value being less than a peak open-circuit voltage value that corresponds to an input storage element voltage value to which the input storage element would rise under excitation if no other circuit elements were attached to it; and

an output storage element, connected to the controlled conversion element, and to store energy received from the converted signal.

2. An apparatus as in claim 1 wherein the controlled conversion element further comprises:

a switch, connected to receive the energy signal originated by the transducer, and to provide a switched energy signal therefrom; and

a voltage controller, connected to control the switch.

3. An apparatus as in claim 1 wherein a center point of the controlled operating voltage range is about one-half of the peak open-circuit voltage value.

4. An apparatus as in claim 1 additionally comprising:

a rectifying bridge, connected to the transducer, for receiving an electrical signal therefrom and for providing the energy signal as a rectified signal.

5. An apparatus as in claim 1 additionally comprising:

a load circuit, connected to receive energy from the output storage element.

6. An apparatus as in claim 5 wherein the controlled operating voltage range is derived by determining a maximum average power throughput from the transducer to the load circuit.

7. An apparatus as in claim 2 wherein the controlled conversion element additionally comprises:

a Direct Current to Direct Current (DC-DC) converter, connected to receive the switched energy signal, and to provide energy to the output storage element.

8. An apparatus as in claim 7 wherein the DC-DC converter couples electric power from the switched energy signal to a load circuit.

9. An apparatus as in claim 1 wherein the apparatus is self-powered from harvested energy.

10. An apparatus as in claim 1 wherein the conversion element is powered from harvested energy.

11. An apparatus as in claim 1 wherein the controlled conversion element uses an external controller to set the high and low operating voltage values.

12. An apparatus as in claim 11 wherein the external controller is powered from harvested energy.

13. An apparatus as in claim 1 wherein the controlled operating voltage range is programmable.

14. An apparatus as in claim 1 wherein the controlled operating voltage range is set by bias points in an electronic circuit.

15. An apparatus as in claim 7 wherein the controlled conversion element ensures that the DC-DC converter controls the energy signal such that the conversion element runs discontinuously in such a manner to approximately optimize power transfer from the input storage element to the output storage element.

16. An apparatus as in claim 2 wherein the controlled conversion element further comprises:

a pair of Zener diodes, arranged to determine the high and low controlled operating voltages respectively; and

a pair of transistors, arranged to activate the voltage sensing switch.

17. An apparatus as in claim 16 wherein the controlled conversion element additionally comprises:

one or more bias resistors, a shunt capacitor, and a diode arranged to control current flow through the voltage sensing switch.

18. A method for harvesting energy from a transducer comprising:

storing electrical energy received from an energy signal originated by the transducer in an input storage element;

converting the energy stored by the input storage element in a controlled fashion to provide a converted signal therefrom, the conversion constraining an input storage element voltage value to vary only within a controlled operating voltage range that varies from a low operating voltage value to a high operating voltage value, the high operating voltage value being less than a peak open-circuit voltage value that corresponds to an input voltage value to which the input storage element would rise if not other circuit elements were attached to it; and

further storing energy in the converted signal in an output storage element.

19. A method as in claim 18 wherein the step of controlled converting further comprises:

providing a switched energy signal from a voltage switch connected to receive the energy signal originated by the transducer; and

controlling the voltage sensing switch.

20. A method as in claim 18 wherein a center point of the controlled operating voltage range is about one-half of the peak open-circuit voltage value.

21. A method as in claim 18 additionally comprising:

rectifying an electrical signal produced by the transducer, to provide the energy signal as a rectified energy signal.

22. A method as in claim 18 additionally comprising:

connecting a load circuit to receive energy from the output storage element.

23. A method as in claim 22 wherein the controlled operating voltage range is derived by determining a maximum average power throughput from the transducer to the load circuit.

24. A method as in claim 19 wherein the voltage sensing switch additionally comprises:

performing a Direct Current to Direct Current (DC-DC) conversion on the switched energy signal to provide energy to the output storage element.

25. A method as in claim 18 additionally comprising:

self-powering the apparatus from harvested energy.

26. A method as in claim 18 wherein the conversion step is powered from harvested energy.

27. A method as in claim 18 additionally comprising:

setting the controlled operating voltage range under programmable control.

28. A method as in claim 18 additionally comprising:

setting the controlled operating voltage range via bias points in an electronic circuit.

29. A method as in claim 19 additionally comprising the step of:

controlling the energy signal such that the controlled conversion element runs discontinuously in such a manner to approximately optimize power transfer from the input storage element to the output storage element.

30. A method as in claim 18 additionally comprising:

operating a pair of Zener diodes, arranged to determine the high and low controlled operating voltages respectively; and

activating the voltage sensing switch via a pair of transistors.

31. A method as in claim 30 additionally comprising:

operating one or more bias resistors, a shunt capacitor, and a diode arranged to control current flow through the voltage sensing switch.